

REMARKS

This application was originally filed on 17 September 2003 with eighty total claims, five of which were written in independent form. Claims 4, 22, 23, 30-62, 65, and 72-80 have been canceled, and Claims 1, 15, 24-26, 63, and 66 have been previously amended. Claim 64 has been amended, and Claims 81-83 added by this response. No claims have been allowed.

As there are now 37 total, and 5 independent claims pending, it is believed no additional claim fees are due as a result of this amendment. Nevertheless, please charge any necessary fees, including extension of time fees, to the deposit account of Texas Instruments Incorporated, Deposit Account No. 20-0668.

Claim 64 was rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention. Claim 64 has been amended to change “the measure parameter” to “the parameter” in order to provide proper antecedent basis for the term “parameter.”

Claim 1 was rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Application Publication No. 2002/0011463 A1 to Buskirk *et al.* (“Buskirk”) in view of U.S. Patent No. 6,784,108 to Donohue *et al.* (“Donohue”), and further in view of U.S. Patent No. 6,893,974 to Sedigh *et al.* (“Sedigh”). The applicant respectfully disagrees.

Claim 1 recites, *inter alia*, “detecting an amount of a chemical species flowing out of the etch chamber resulting from etching of the sacrificial material from the present spontaneous vapor phase etchant recipe; measuring the amount of the chemical species in the process; determining a feeding time based on the measurement; and further etching the sacrificial material by providing an additional amount of the spontaneous vapor phase etchant recipe to the etch system based on the determined feeding time to continue the process.”

The Examiner stated, “Buskirk does not specifically disclose determining a feeding time based on the measurement of the amount of a chemical species/etchants[.] Donohue discloses a etch profile control method comprises a step of determining a feeding time based on the measurement of the amount of a chemical species/etchants (col. 10, lines 49-54; fig. 17). Donohue serves as an evidence that the feeding time is a result effective variable[.]”

The applicant respectfully submits that the Examiner is mischaracterizing Donohue. Donohue states, “An example is presented here for the purpose of introducing and illustrating

terminology that is used in this specification. For simplicity, only one gas is considered under pulsing conditions in this example. When this gas is flowed at 18 sccm for 18 s and then flowed at 28 sccm for 14 s, the period for this pulsed process is $14\text{ s} + 18\text{ s} = 32\text{ s}$. The flow of 28 sccm for 14 s provides the conditions that enhance protective layer formation, whereas the flow of 18 sccm for 18 s provides the conditions that do not enhance protective layer formation” (col. 10, lines 47-56). Thus, Donohue appears to merely teach pulsing an etch gas to achieve two different conditions.

The Examiner further stated, “Buskirk also fails to disclose detecting an amount of chemical species flowing out of the etch chamber resulting from etching of the sacrificial material from the present spontaneous vapor phase etchant recipe[.] Sedigh discloses collecting data/parameter/chemical species from a first etching process, determining deviations from the data analyzed in the first etching process and adjusting the process conditions/parameters/chemical species for subsequent substrates based on the data obtained and analyzed in the previous etching process (col 9, lines 1-27, col 11, lines 17-34)[.]”

The applicant respectfully submits the Examiner is mischaracterizing Sedigh. Sedigh states:

“In one example, optical emission spectroscopy endpoint detection systems monitor the optical components of the plasma generated by the etch chemistry during an etch process. Some of the optical components, such as wavelength of light, are specific to the material being etched. Thus, by monitoring a wavelength of light, which is specific to the material being etched, the system can detect when one layer of the material has been removed to expose an underlying layer of the material. There are, however, several disadvantages to etching one or more openings using an endpoint detection system, such as an optical emission spectroscopy system. For example, the sensitivity of the system is generally determined by the etch rate and the total area being etched. Thus, an endpoint may be difficult to detect for slow etch processes. In addition, special test sites may be needed when small openings are being etched, or when the depths become comparable to the separation between semiconductor features (e.g., in high aspect ratio openings). In another example, laser interferometry

endpoint detection systems may be used to monitor the optical components of material being etched during an etch process. Some of the optical components, such as refractive index, are specific to the material being etched. Thus, by monitoring the amplitude of the intensity of reflected light from the etched material, the system can detect when one layer of the material has been removed to expose an underlying layer.” (col. 9, lines 1-27)

And:

“In any embodiment, the step of processing the one or more pre-etch values (i.e., step 92) may further include comparing the incoming pre-etch values to a collection of pre-etch values of previously processed semiconductor topographies. In some cases, the collection of pre-etch values may be in the form of a historical database, as will be described in more detail below in reference to FIG. 8. In any case, the collection of pre-etch values may further include information relating pre-etch values to particular sets of etch parameters. For example, a semiconductor wafer having a mean dielectric layer thickness of approximately 6,000 [angst] may be etched with one set of etch parameters, while another semiconductor wafer having a mean dielectric layer thickness of approximately 10,000 [angst] may be etched with another set of etch parameters. Note, however, that such an example is only one example of the embodiment described herein. In some cases, the sets of etch parameters may be different due to the difference between the pre-etch values.” (col. 11, lines 17-34)

Thus, Sedigh appears to teach away from endpoint detection systems and instead advocates the determination of etch process durations based on the pre-etch measurement of physical dimensions and reliance on historical data from etching other similar substrates.

Thus, the prior art references relied upon by the Examiner, in combination, do not appear to support the Examiner’s rejection of Claim 1. As such, the rejection of Claim 1 under 35 U.S.C. § 103(a) is defective and should be withdrawn.

Claims 2, 5, 6, 10-12, 15, 17, and 26-27 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Buskirk in view of Donohue, and further in view of Sedigh. Claims 7, 8, 13 and 14 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Buskirk in view of

Donohue and Sedigh, and further in view of U.S Patent No. 6,436,229 to Tai *et al.* (“Tai”). Claim 9 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Buskirk in view of Donohue and Sedigh, and further in view of U.S Patent No. 6,162,585 to Zhang *et al.* (“Zhang”). Claim 16 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Buskirk in view of Donohue and Sedigh, and further in view of U.S Patent No. 6,162,585 to Zhang *et al.* (“Zhang”). Claims 18-21 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Buskirk in view of Donohue and Sedigh, and further in view of U.S Patent No. 6,740,247 to Han *et al.* (“Han”).

Claims 2, 3, 5-21, and 24-29 depend from Claim 1 and should be deemed allowable for that reason and on their own merits. For the reasons given above with respect to Claim 1, the Examiner’s rejection of Claim 1 is unsupported by the prior art and should be withdrawn. The rejections of the dependent claim inherit this same flaw and therefore should also be withdrawn.

Claim 63 was rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Application Publication No. 2002/0033229 A1 to Lebouitz *et al.* (“Lebouitz”) in view of Sedigh.

Claim 63 has been amended to recite, “collecting data of a parameter during a first etching process for a first microstructure using an etchant recipe that comprises a spontaneous vapor phase etchant; determining a variation profile of the parameter in the first etch process; and etching a second microstructure in a second etching process using the etchant recipe based on the collected data of the parameter in the first etching process and adapting said second etching process based on monitoring said parameter during said second etch process, and wherein the parameter is a detected chemical species during the etch.”

The Examiner stated “Sedigh discloses that using feed forward control of the etch process parameter/ etchant/chemical species advantageously fabricates openings having profiles and dimensions, which exhibit little to no deviation from a design specification (see abstract).”

The applicant respectfully submits that abstract of Sedigh, cited by the Examiner, teaches the use of pre-etch values to determine some of the etch process parameters, not “adapting said second etching process based on monitoring said parameter during said second etch process” as recited by amended Claim 63.

Claims 64, 66, and 68-71 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Lebouitz in view of Sedigh. Claim 67 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Lebouitz in view of Sedigh, and further in view of Tai.

Claims 64, 66, and 68-71 depend from Claim 63 and should be deemed allowable for that reason and on their own merits. For the reasons given above with respect to Claim 63, the prior art does not show, teach, or suggest the limitations of the independent claim, much less the limitations of the independent claim in combination with the additional limitations of the dependent claims, and therefore should be withdrawn.

Claims 3, 24, and 25 were objected to by the Examiner, but were deemed allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Newly added Claims 81-83 are similar to Claims 3, 24, and 25 and should be deemed allowable for that reason.

In view of the amendments and the remarks presented herewith, it is believed that the claims currently in the application accord with the requirements of 35 U.S.C. § 112 and are allowable over the prior art of record. Therefore, it is urged that the pending claims are in condition for allowance. Reconsideration of the present application is respectfully requested.

Respectfully submitted,

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